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CALENDAR YEAR 2003

WELL INSTALLATION AND

SAMPLING PROJECT

WORK PLAN

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1.0 Introduction

New groundwater monitoring wells are needed at the Rocky Flats Environmental Technology Site (RFETS; the Site) to fill data gaps identified through recent characterization and cleanup activities and to support volatile organic compound (VOC) groundwater modeling efforts. This Work Plan (WP) presents the rationale supporting each well installation, the design of each well, and the initial sampling requirements, including the collection of surface water grab samples. Subsequent sampling requirements will be determined based on a review of the resulting data.

Well installations will take place in Calendar Year 2003 (CY03).

Surface water samples will also be collected in areas that may be effected by contaminants in groundwater and in other areas identified by the Comprehensive Risk Analysis (CRA) project. The CRA requires the collection of surface water data from numerous locations to ensure data adequacy for risk assessment; this WP implements sampling to fill that need. Most of the surface water samples are located will be collected from surface water bodies that are downgradient of identified groundwater sources. Surface water samples will be analyzed for VOCs, semi-volatile organic compounds (SVOCs), radionuclides, metals, and, in some locations, nitrate.

The WP is organized as follows: Section 2 presents a generalized summary of the areas where these wells will be installed and reasons for their installation; Section 3 presents data quality objectives (DQOs) for each well; Section 4 discusses well installation and design requirements; and Section 5 identifies the initial sampling and analytical requirements.

2.0 General Description of Areas of Investigation

This WP implements the installation of 15 monitoring wells distributed among 6 general areas: the Ash Pits; the Oil Burn Pit/Building 991 area; the Ryan's Pit/903 Pad Plume; the Portal 2 parking lot; the 400 Area; and the East Trenches Plume. Each area is briefly discussed below; proposed well locations are shown on Figure 1. Details on the new well installations, including well design and sampling requirements, are presented in Section 5.

Surface water sampling is also required in many of these areas, as well as in additional areas to support the CRA. Data from these 28 sampling locations will support the evaluations associated with the well installations as well as the needs of the CRA project. . Proposed surface water sampling locations are shown on Figure 2 and discussed below.

2.1 Ash Pits

Two wells will be located in the Ash Pits area (Individual Hazardous Substance Site, or IHSS, 133) of the Woman Creek drainage. Figure 1 shows the individual Ash Pits according to their IHSS or Potential Area of Concern (PAC) identification codes.

The Ash Pits have been assigned "No Further Action" closure status. However, via a March 3, 2003 document entitled "Assessment of RFETS Ground Water Status and Needs", the Colorado Department of Public Health and the Environment (CDPHE) has requested additional characterization of groundwater in the area.

Results of samples collected directly from the Ash Pits indicate soils in some Ash Pits are contaminated with elevated beryllium concentrations and uranium activities exceeding Wildlife Refuge Worker Action Levels. Existing groundwater data, generally from the mid-1990s, indicate varying levels of groundwater contamination, with metals and uranium as the most common contaminants.

Monitoring wells are present downgradient of three of the Ash Pits, two of which contain soils with elevated levels of uranium and, in some cases, beryllium. Two other Ash Pits with elevated uranium and/or beryllium have no wells downgradient of them. One well each shall be installed downgradient of these two Ash Pits. Surface water grab samples upgradient and downgradient of the Ash Pits shall also be collected to help determine if the Ash Pits area may be affecting surface water quality.

2.2 Oil Burn Pit/Mound Plume/Building 991

Four wells are proposed for this general area: two downgradient of the Oil Burn Pit (OBP; IHSS 153), one downgradient of Building 991 (B991), and one south of the former Solar Evaporation Ponds (SEPs). This last well is a replacement rather than a new well.

OBP/Mound Plume
Two wells are proposed for the area north of the OBP: one close to and north (downgradient) of the source, and one farther from the source to the north, in or immediately south of the original South Walnut Creek drainage.

Soil sampling was performed in 2002 at and around the OBP, which is generally south-southwest of B995, the Sewage Treatment Plant. Results indicated the presence of VOC soil contamination, with PCE as the main contaminant (exceeding Wildlife Refuge Worker Action Levels in some locations); PCBs also exceeded these action levels in some locations. Although there have been no reports in this area of non-aqueous phase liquid (NAPL, often further described as dense or light, DNAPL or LNAPL, respectively), the Geoprobe™/well installation crew should confirm the presence or absence of staining and/or NAPL during core logging.

Groundwater in the area generally north of the OBP (towards South Walnut Creek) requires additional characterization. Wells have not been previously installed here because this area was occupied by the old Protected Area (PA) security fences. While current data suggest the groundwater flow direction is northeastward toward the Mound Site Plume Treatment System (MSPTS), additional groundwater data are needed to help determine the extent of groundwater contamination and whether the contaminated groundwater is collected by the MSPTS.

One surface water grab sample will be collected from the upper reach of South Walnut Creek, directly downgradient of the Mound Plume. This sample will help to evaluate whether contaminants from the OBP and/or Mound are impacting surface water quality.

B991
One well shall be installed in the vicinity of B992 to evaluate groundwater VOC contamination and its potential impact to surface water.

Groundwater south of B991 is not well characterized. Recent soil excavations in the vicinity of B992 (the old guard tower, which has since been demolished) contained elevated concentrations of VOCs and may be a groundwater contaminant source. Additional soil sampling performed in 2003 verified the limited extent of contamination. This contamination is very close to – almost within – the surface water drainage. The main contaminant is PCE. NAPL was not reported, but the Geoprobe™/well installation crew should confirm the presence or absence of staining and/or NAPL during core logging.

SEPs
Well 00297 is in the Integrated Monitoring Plan (IMP) and fully penetrates the alluvium but screens less than two feet of the weathered bedrock. This well is typically dry. Other wells in this area that screen the weathered bedrock typically produce groundwater, and results have shown that contaminated groundwater is present in the weathered bedrock in the area of the former SEPs.

Therefore, well 00297 shall be replaced by a well that is screened through the weathered bedrock. A surface water grab sample will also be collected downgradient of the SEP. A sample will be collected in North Walnut Creek, downgradient of the SEP plume and in each of the A-Ponds.

2.3 Ryan's Pit/903 Pad Plume

Four wells shall be installed in the area generally south of the 903 Pad.

The extent of groundwater contamination in the area between Ryan's Pit and the southern lobe of the Ryan's Pit/903 Pad Plume is not fully determined. Various interpretations are possible that bear on the understanding of contaminant sources, the hydraulic gradient, contaminant pathways, inputs to flow and transport modeling efforts, and the potential impact to surface water. Contaminants include PCE, TCE, and carbon tetrachloride above groundwater Tier I Action Levels, and other VOCs at lower concentrations. Uranium is also present at elevated levels in the groundwater.

Three wells shall be installed in this area to provide data that should allow a better understanding of groundwater contaminant extent and transport, thereby supporting modeling and monitoring efforts here.

A fourth well shall be installed more directly downgradient of the Ryan's Pit source area. Current potentiometric contours suggest that the plume migration path is toward this fourth location, rather than the more easterly path currently shown on plume maps. A line of wells was installed in 1998 to define the Ryan's Pit Plume, but many were dry. This may be because the 1998 wells are too shallow; even though most screen the upper weathered bedrock, they do not fully penetrate the weathered zone. The new well shall be installed to screen the entire weathered bedrock interval to evaluate whether contaminated groundwater is migrating through this material in a direction that more closely reflects the flow direction, as it is currently understood. This well will be located between wells 00598 (where the bedrock contact is reported at 15.9' below ground surface, or bgs) and 00698 (bedrock reported at 10.0' bgs), but nearer well 00598 in case it is situated within a paleochannel. (The bedrock contact in the next well to the west, 00498, is reported at 9.7' bgs.)

All four of these wells will assist in the evaluation of contaminant distribution and extent, natural attenuation, and groundwater gradients in this area, and will support modeling efforts focusing on the Ryan's Pit/903 Pad Plume.

Surface water grab samples shall also be collected in the SID, Pond C-1, and in Woman Creek to help determine if this plume may be affecting surface water quality. Samples will also be collected from Pond C-2 for the CRA project.

2.4 Portal 2 Parking Lot

Three wells shall be installed within or along a buried drainage underneath the Portal 2 (PACS 2) parking lot, generally north to northeast of well 33502. Additional wells, for example on the B371/374 side of the PA, will be considered if these wells indicate contaminated groundwater may extend throughout the entire length of the buried drainage. If necessary, any additional wells will be installed via another WP.

Well 33502, which was installed in late 2002, revealed previously-unknown groundwater contamination within this buried drainage. Concentrations of vinyl chloride in groundwater exceed Tier I at this location. Wells near the northern end of this buried drainage (north of the B371/374 PA fence) do not reflect these concentrations. However, those wells are shallow and do not fully penetrate the drainage.

During shallow subsurface investigations in this area in the early 1990s, NAPL was observed on drill tool surfaces. Subsurface soil sampling was performed in 2002 to confirm the presence of NAPL, and well 33502 was installed to characterize groundwater in the immediate vicinity of the earlier intrusive activity. However, DNAPL was not found during the sampling or well installation activities at 33502, though the water generated during those activities and subsequent groundwater sampling activities had an oily sheen and produced a strong odor. Because of the potential for DNAPL at this location, a stainless steel well was installed. As the wells to be installed via this WP will be farther from this location, there is no expectation of DNAPL at these new well locations. Even so, the Geoprobe™ /well installation crew should note the presence or absence of staining and/or DNAPL during core logging.

Two of the new wells shall be installed to fully penetrate this buried drainage in locations that are increasingly downstream of well 33502 to evaluate the extent of contamination and potential impact to surface water. The third well shall be installed on the northwestern side of the buried drainage to determine the lateral extent of vinyl chloride.

Surface water grab samples shall also be collected near Portal 2 and downgradient in North Walnut Creek to help determine if this plume may be affecting surface water quality.

2.5 400 Area/Original Landfill

One well is proposed for the 400 Area immediately east of B443, the steam plant.

During characterization activities in late FY03, subsurface soil characterization efforts utilizing a Geoprobe™ intercepted NAPL (diesel) in several locations surrounding underground tanks on the eastern side of the building. This well shall be installed to evaluate the extent of groundwater contamination downgradient of B443, as existing wells are not positioned appropriately to make this determination. The new well will target the area just east of an east-west utility corridor that originates in the vicinity of the underground tanks.

Surface water grab samples will be collected downgradient of the South Industrial Area Plume (SIAP) in the SID and in Woman Creek to support the CRA project. Data from these samples will be used to evaluate surface water quality impacts that may result from the SIAP and/or the Original Landfill.

2.6 East Trenches Plume

One well is proposed for the East Trenches Plume and several surface water grab samples shall be collected.

The well shall be installed to evaluate the northeastern groundwater contaminant plume extent. In particular, this well will furnish data to clarify the configuration and extent of two lobes of the East Trenches Plume for contaminant transport modeling. The exact location of this well may be adjusted through additional discussion with modeling staff, but probably will not deviate significantly from the location shown on Figure 1. Groundwater contaminants in this area include low concentrations (Tier II or less) of PCE, TCE, carbon tetrachloride, and their degradation products.

Surface water grab samples shall also be collected from several locations along South Walnut Creek and the B-Ponds to help determine the extent to which surface water quality may have been affected by this plume. Additional sampling along South Walnut Creek will support the CRA project.

2.7 Present Landfill

One surface water grab sample will be collected from the Present Landfill Pond to support the CRA project. The sample will be collected from the west end of the pond nearest the landfill face.

3.0 Data Quality Objectives (DQOs)

It is evident from the preceding summaries that the fourteen wells and the surface water grab samples have differing DQOs. This section presents the DQOs. There are no DQOs presented for the well replacement (00203) at the former Solar Evaporation Ponds, as this well merely replaces an existing IMP well (00297).

3.1 State the Problem

Data gaps have been identified that warrant the installation of new groundwater monitoring wells to provide information on VOC, metals, petroleum hydrocarbons, and/or uranium contamination. The new wells are intended to fill these data gaps and provide groundwater quality data that will assist in the determination of contaminant plume extent and the potential for discharge of contaminated groundwater to surface water.

Data gaps have also been identified that warrant the sampling of surface water locations in several areas of the Site. Some of these data gaps concern whether groundwater plumes are impacting surface water quality, and others are related to the CRA data adequacy evaluation. Regardless of the intended use of the resulting data, all but one of the surface water locations will provide information on VOC, SVOCs, metals, uranium, plutonium, americium, and in some cases nitrate contamination. (The exception is a single location that was sampled before this WP was revised to include CRA data needs.) The analytical results from these samples are intended to fill these data gaps and provide surface water quality data that will assist in the determination of contaminant plume extent and the potential discharge of contaminated groundwater to surface water.

3.2 Identify the Decision

Decisions to be made using data collected from the groundwater monitoring wells installed and sampled during this project include:

- Is there contaminated groundwater in the Ash Pits (IHSS 133 group) area, and is there a potential impact to surface water?
- Is there a potential impact to surface water from the Original Landfill and/or from the South Industrial Area Plume?
- Does the Oil Burn Pit (IHSS 153) cause previously-unrecognized groundwater contamination, and if so, is there a potential for this contamination to impact surface water?
- Does soil contamination in the area immediately southwest of B991 act as a previously-unrecognized source of contaminated groundwater, and is there a potential impact to surface water?
- What is the distribution of contaminants where the 903 Pad and Ryan's Pit Plumes are thought to commingle?
- Does contaminated groundwater from the Ryan's Pit source area migrate through the weathered bedrock, and does this contamination reach surface water in the SID, Woman Creek, or the C-Ponds?
- Does the buried drainage south of B371 serve as a preferential pathway for contaminated groundwater to reach surface water?
- What is the extent and configuration of the contaminant plume south of B371?

- Is groundwater impacted downgradient (east) of B443 as a result of free-phase diesel discovered in late FY03, and if so, what is the extent and configuration of the hydrocarbon plume?
- Does groundwater contamination originating in the 440 Area (South Industrial Area Plume) reach the Sid or Woman Creek?
- What is the configuration of the two northeastern components of the East Trenches Plume in the area in which they are thought to commingle?
- Do VOCs from the East Trenches Plume influence surface water quality in the upper B Ponds (B-1, B-2, B-3, B-4) and intervening reaches of South Walnut Creek?
- Do VOCs from the Mound Plume/Oil Burn Pit influence surface water quality in the upper reaches of South Walnut Creek?
- Do VOC distributions (if present) in the B-Ponds and South Walnut Creek indicate these VOCs are volatilizing?
- Is contaminated groundwater from the 700 Area or the SEP Plume influencing surface water quality in the upper reach of North Walnut Creek or the A-Ponds?
- Is the Original Landfill impacting surface water quality in the Landfill Pond?
- Do any of the areas being investigated exhibit conditions indicative of biodegradation of VOCs?
- Do sufficient SW data exist to adequately perform human health and ecological risk assessments?

3.3 Identify Inputs to the Decision

Inputs to the decision include groundwater and surface water analytical data and, in some cases, surface water data combined with spatial coordinates (i.e., where a sampling location is with respect to known sources of contamination). These data will be used to determine the presence or absence and concentration of groundwater contamination in the areas being investigated through this WP. The specific contaminants, if any, will also be important inputs. Sampling shall be performed in accordance with this WP and the appropriate Site procedures, which include RMRS/OPS-PRO.113, Groundwater Sampling, and RMRS/OPS-PRO.081, Surface Water Sampling.

Geologic core will provide additional inputs to the decision, as will other field observations focusing on geologic materials and intrusive activities.

Further inputs to the decision include water level measurements from new and existing monitoring wells, which can be used to delineate groundwater flow directions for interpretation of contaminant transport pathways. Land or global positioning system (GPS) surveying of new well locations and casing elevations shall be conducted as per RMRS/OPS-PRO.123, *Land Surveying,* and/or the GPS operator instructions, to provide control for potentiometric contouring.

3.4 Define the Boundaries

The investigation rationale is detailed in Sections 1 and 2 of this WP. The proposed well locations are shown on Figure 1, and surface water sample locations are shown on Figure 2. These figures also show the VOC plume boundaries. Except at the Ash Pits, SEPs/North Walnut Creek, Original Landfill, and Present Landfill, the boundaries are generally defined or influenced by known VOC contamination in and around the IA, most of which is evident as VOC-contaminated plumes of groundwater. These plumes are shown on "composite" VOC plume maps that have been presented in recent Annual RFCA Groundwater Monitoring Reports and include the central IA, Mound/East Trenches/OU2 area, 903 Pad/Ryan's Pit area, SEP area, PU&D Yard/Present Landfill area, and smaller areas along the southern margin of the IA.

At the Ash Pits, the boundaries extend from the Ash Pits southward to (and including) Woman Creek. In North Walnut Creek (including the SEP area), the boundaries extend from just upstream of the confluence with the unnamed drainage separating B371/374 from B776 and B771, to Pond A-4; the outflow from the culvert into this unnamed drainage will also be sampled. At the Original Landfill, the boundaries encompass the SID across the known extent of this Landfill as well as a point on Woman Creek due south of the easternmost (downstream) location on the SID. At the Present Landfill, the boundaries coincide with that portion of the East Landfill Pond that is both easily accessible for sampling and is closest to the face of this Landfill. In the Mound/Oil Burn Pit/East Trenches Plume area, the boundaries extend from South Walnut Creek downgradient of the northeastern component of this plume (typically referred to as the Mound Plume), near where the creek exits the culvert beneath the former Protected Area border just east of Building 991, eastward within the South Walnut Creek drainage to (and including) Pond B-5.

3.5 Decision Rule

If contaminants are detected in a new well, the analytes and concentrations shall be compared with existing data from the area (soil, groundwater, and/or surface water) to assess the potential impacts to groundwater. Follow-up samples may be collected to confirm initial results and, in some cases, additional wells may be proposed.

Surface water results generated through this WP will be used along with groundwater data to delineate the extent of groundwater plumes, their impact on surface water, and to assess risks and hazards to humans and the ecological community. Follow-up surface water samples may be necessary to confirm the presence, magnitude, and extent of any impact from groundwater. Depending on the contaminants and their concentrations as compared to Action Levels, establishing a regularly-sampled surface water monitoring station in the area or adding to the analytical suite collected at existing stations may be considered.

Flow direction and hydraulic gradients determined from groundwater level data will be combined with analytical data to evaluate the potential for contaminated groundwater to discharge to surface water. In areas not subject to surface water sampling, if the water level and analytical data indicate such a discharge is likely, surface water sampling will be considered.

Geologic core shall be logged and archived. Core logs will be evaluated with respect to the types of data previously discussed to determine whether other factors may be controlling contaminant distribution and migration. For example, if core indicates that a fracture zone or sand lens may be directing contaminant migration in an unanticipated direction, additional well installations may be proposed. Core from areas of artificial fill, such as the OBP, B991, and the buried drainage south of B371, shall be carefully examined for evidence of contamination (e.g., DNAPL staining) and unusual content (such as graphite chunks or other man-made materials), as well as for indications of enhanced permeability (that is, relative to undisturbed materials).

3.6 Limits on Decision Errors

Additional characterization, if required, will be based upon an evaluation of data collected under this WP compared with historical data (for pre-existing wells) and other data from the area around each well and surface water sampling location. An evaluation of data quality will be performed on laboratory data utilizing precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters and data validation. Data validation typically is performed on 25 percent of the laboratory analytical data, while the remaining 75% is verified.

Well locations (Figure 1) are based on previous hydrogeologic investigations; more recent soil characterization activities and field observations; interpretation of groundwater flow directions and contaminant distributions; the location of production facilities, contaminant releases, disposal pits,

and utility corridors; the location of pre-RFETS drainages; and VOC modeling needs. Surface water sampling locations were identified based on the same information as well as CRA data needs. Groundwater monitoring and surface water sampling shall be performed in accordance with this WP and appropriate task-specific Standard Operating Procedures (SOPs).

3.7 Optimize the Design

If further characterization is required to evaluate or confirm results obtained through the sampling activities described in this WP, such as resampling of selected wells or surface water locations, installation of additional wells, or collection of additional analytes, these activities shall be conducted under the rules and procedures outlined in this WP or, if appropriate, through a separate WP or the IMP.

4.0 Well Installation and Design

All wells shall be installed using a Geoprobe™ in accordance with RMRS/OPS-PRO.124, Push Subsurface Soil Sampling, and PRO-1059-WELL-118, Monitoring Well Installation, as modified in this WP. Well installation activities, geologic conditions, and any other information and observations that may be pertinent to the well and/or the groundwater that will be monitored by the well shall be recorded in detail in a field logbook identified for use with this WP and completed in accordance with PRO-1457-UL, Use of Logbooks.

Intrusive activities shall not begin until an approved Soil Disturbance Permit (SDP) is obtained and intrusive locations are cleared. Final well installation locations shall be based upon results of the borehole clearing activity as well as close inspection of available maps, including those of IHSSs, wells, and the pre-RFETS land surface. This will be especially critical in some areas, as utility coverages may be dense. In addition, the locations that target buried drainages need to avoid culverts that may be installed in those drainages to route flow.

All downhole tooling and equipment shall be decontaminated prior to use at the first location to remove any potential contaminants and dust that may have accumulated since the items were last used. This equipment shall be decontaminated again after completing each subsequent location. If tip refusal is encountered and an offset attempt is required, tooling shall be decontaminated before beginning intrusive activities at that offset location.

Although not anticipated, if any free product is intercepted, intrusive activities (probing) shall pause and the WARP Project Manager shall be consulted to ensure that proper health and safety supplies, well construction materials (i.e., stainless steel instead of PVC), and other necessities are on hand and supervisory personnel are aware of the discovery. Due to the potential for cross-contamination across the borehole or between boreholes, e.g., by penetration of a low-permeability layer on which a pool of NAPL is perched or by contaminating downhole tools, it is critical that NAPL that may be present is quickly identified. Obviously, health and safety issues are also critical anytime NAPL is identified; adherence to the HASP is extremely important.

Each well shall be constructed of clean, flush-threaded, one-inch inner diameter (1" ID) schedule 40 or schedule 80 PVC blank and screen, with a threaded bottom cap (no sump). Any well that screens materials containing NAPL shall be constructed of stainless steel or other inert material of the same ID. If well components (blank or slotted casing) are furnished with O-rings, the O-rings shall be removed prior to well assembly and installation to minimize the potential for their degradation products to be detected in samples. The screen components shall be factory cut with 0.010-inch slots and, if not received in factory-decontaminated and impermeably-packaged form, shall be decontaminated before use. Filter pack shall consist of 16/40 grade, environmental quality, silica sand. The borehole above the top of the filter pack shall be backfilled with granular bentonite. In areas of vehicular traffic, flush-mount well protection shall be installed; otherwise, a 2"

PVC protective casing may be installed as described in PRO-1059-WELL-118. All wells shall be secured with Site-standard well locks immediately following installation.

If refusal is encountered prior to obtaining the target depth, the Rig Geologist shall contact the WARP Project Manager to determine the course of action. If near the target depth and in an appropriate geologic material, it may be appropriate to install the well at that depth; otherwise, an offset attempt may be required, which may entail further utility clearance activities and/or special modifications to the SDP.

4.1 General Well Design Guidelines

Screened intervals will vary by area. The general guidelines below should be followed when installing each well, with certain exceptions that are discussed later in this section:

- If bedrock sandstones are intercepted within the weathered bedrock, they should be fully penetrated and included in the screened interval.
- Each well shall screen a minimum of 10' of weathered bedrock unless the specific well design indicates otherwise.
- The well screen in all cases should extend upward to include at least the lower 3' of the unconsolidated surficial materials (e.g., alluvium, colluvium), except where this would cause the top of the screen to be shallower than 5' bgs. See next items.
- The top of the screen should be positioned a few feet above the anticipated high water level, unless that is 5' bgs or less, with the filter pack extending another 6" to 2' above the top of the screen.
- The top of the filter pack shall be no shallower than 3.5' bgs.
- The granular bentonite seal shall be installed carefully and hydrated immediately after installation, using distilled or deionized water.

4.2 Exceptions to General Guidelines

There are several conditions that would require deviation from some of the above general guidelines. These are as follows:

(1) If a NAPL is observed at any depth, the well design and probing objectives will change. (For example, the materials of well construction will be changed, and further probing in order to achieve the target depth may be canceled.) Of critical importance will be the need to quickly recognize the NAPL and ensure that any low-permeability material underlying it is not penetrated by the Geoprobe™. For these reasons and for health and safety reasons, the Geoprobe™ well installation crew shall halt intrusive activities immediately upon detection of any NAPL, and shall contact the WARP Project Manager for further direction.

(2) If the well is intended to screen the entire weathered bedrock interval and no NAPLs are detected, the well shall fully penetrate the weathered zone. The base of the weathered zone shall be determined as the depth below which at least two feet of unstained and otherwise unweathered bedrock core have been recovered. It is common for intervals of up to four or five feet of unweathered bedrock to be recovered, followed by an interval with mottled staining indicative of weathering. However, for the purposes of these wells, the previous definition (two feet of unweathered bedrock) will suffice.

(3) If the well is to be installed within a buried drainage, and core recovered from the borehole indicates the drainage is underlain by relatively impermeable claystone (as opposed to coarser materials or fractured claystone), the borehole shall not advance through more than 5' of bedrock without specific direction from the WARP Project Manager. This assessment will depend on accurate determination of the bedrock contact, bedrock type, and (if possible) the identification of alluvial materials such as would be found in a typical drainage.

Other exceptions are presented below and pertain to the specific well installation areas.

4.3 Area-Specific Guidelines

The area-specific guidelines, which only apply to a few of the wells, are as follows.

- Wells in the Ash Pits must be screened to below the reported depth of the Ash Pits themselves (approximately 10'). Therefore, the total depth of Ash Pits wells will exceed this depth or the bedrock contact depth, whichever is greater, by at least 5'. For example, if the bedrock contact is observed at 8' bgs, the minimum depth of the well would be 15' bgs (10' deep trench plus 5'); if the contact is observed at 13', the minimum depth would be 18' bgs (13' deep contact plus 5'). Geologic considerations (fracturing, sandy zones, etc.) may cause this depth to increase beyond the extra 5'.

- Wells in the OBP area shall screen through all artificial fill, whether it represents displaced bedrock or is more alluvial in nature. Because construction of the PA could have displaced fairly large blocks of claystone from the bedrock, a minimum of 5' of uninterrupted bedrock material shall be recovered before making the final determination as to depth of bedrock. Due to the high levels of VOCs reported in soils near the OBP, workers shall be especially vigilant for elevated photoionization detector (PID) readings or evidence of NAPLs (e.g., staining). In addition, the well to be installed in or immediately south of the original South Walnut Creek drainage may intercept very soft fill underlain by decomposed organic materials and alluvial gravels, representing the original drainage. The Rig Geologist shall be observant of these conditions, and the Geoprobe™ operator shall be very careful when probing through soft fill to maximize core recovery. Exception number 3 in Section 4.2 above may apply at this well. It will also be important to be sure the well location will not intercept any buried culvert (or other utilities).

- The well to be installed near B991 shall target the excavation which produced contaminated soils, but because that excavation was refilled with clean soil, the well needs to be installed on the excavation margin. Consultations with personnel involved in that activity, together with discussions with the Excavation Specialists and the results of the borehole clearing exercise, will finalize the location. This well is not anticipated to be very deep due to its position near the valley bottom.

- Wells in the PACS 2 area shall also screen through all fill, which may be similar to that described for the OBP area because the target is a buried drainage. Again, both the Rig Geologist and the Geoprobe™ operator shall be very careful and pay close attention to probing conditions and recovered core. Exception number 3 in Section 4.2 above may apply at this well. In addition, because of indications of NAPL reported near well 33502 in the early- to mid-'90s, and the recovery of solid graphite in core from 33502, unusual materials may be recovered during intrusive activities at these locations. Workers shall be especially vigilant for elevated PID readings or evidence of NAPL (e.g., staining) and unusual materials in the core. If NAPL is observed, only stainless-steel well components shall be used. Finally, it will be important to avoid any culvert routing water through this buried drainage.

- The well to be installed in the 400 Area, east of B443, may screen less than 10' of the weathered bedrock, but shall fully penetrate the alluvium. The target location for this well is

immediately east of now-demolished B428 and west of a still-existing wooden shed. A utility corridor extends from the eastern side of B443, in the vicinity of locations where free-phase diesel was discovered in characterization efforts performed in late FY03, to B428. This utility corridor may form a preferential pathway for groundwater flow in this area, and may therefore provide the most advantageous location for a monitoring well to determine whether the diesel is impacting groundwater.

4.4 Well Designs

Specific well designs are described in Table 1. The actual well design shall be adjusted in the field based on observed conditions (e.g., bedrock contact, thickness and nature of weathered bedrock).

Table 1. Estimated depths and screened intervals at new wells.

Well	Approx. Bedrock Contact	Approx. Total Depth	Screen Interval	Location and Purpose
13103	12	20	4-20	South of IHSS 133.1 Ash Pit to characterize downgradient groundwater
13403	10	20	4-20	South of IHSS 133.4 Ash Pit to characterize downgradient groundwater
91103	10	22	7-22	Oil Burn Pit groundwater characterization
91203	15	20	10-20	Oil Burn Pit groundwater characterization
99603*	7	15	5-15	B991 groundwater characterization
00203	6	25	5-25	Replace 00297, which was installed too shallow
90603	10	25	5-25	Ryan's Pit/903 Pad Plume characterization, NW
90703	10	25	5-25	Ryan's Pit/903 Pad Plume characterization, NE
90803	20	35	15-35	Ryan's Pit/903 Pad Plume characterization, SE
90903	13	28	8-28	Ryan's Pit/903 Pad Plume characterization, SW weathered bedrock well by shallow wells 00598 and 00698
33603*	40	41	5-41	North-northeast of 33502 to characterize buried drainage
33703*	40	41	5-41	North-northeast of 33603 to characterize buried drainage
33803*	30	35	5-35	West of 33703 to characterize buried drainage
44303	25	30	5-30	East of B443 to characterize groundwater downgradient of subsurface free-phase diesel
95503	28	40	15-40	Approximately between wells 3387 and 95099 to characterize groundwater plume extents

* Install flush-mount surface protection with a brightly painted lid. Other wells shall be equipped with 2" PVC aboveground surface protection and a brightly painted and flagged metal fence post.

Geologic core shall be collected from every location, and shall be described and archived in accordance with RMRS/OPS-PRO.101, Logging Alluvial and Bedrock Material, except that certain activities described in that procedure shall not be performed. Specifically, activities associated with the description and determination of grain size distribution (i.e., sieving and microscopy), plasticity, porosity, and core photography shall not be performed. Qualities that are apt to change over time, such as contamination and evidence of moisture content, shall be checked and described immediately upon retrieval of the core from the borehole.

5.0 Initial Sampling and Data Evaluation

New wells shall be developed, and (at the Ash Pits and selected locations in the 400 Area) pre-existing wells redeveloped, as soon as possible. High-energy development methods (i.e., surging the water column) shall be used unless NAPL is present. (If there is some other reason why high-energy methods are not appropriate, the sampling crew shall contact the WARP Project Manager to discuss specific well development issues prior to initiating them at the well in question.) If NAPL is present at a location, the well shall be developed using low-energy methods incorporating a peristaltic pump to remove accumulated sediments from the well and condition the well bore. The development crew shall take care to minimize the amount of NAPL removed from the well (due to health and safety as well as waste disposal concerns) and the amount spread across the length of the well (for example, as it dribbles out the end of peristaltic pump tubing as that tubing is raised across the screened interval).

Sampling activities, including the well purge performed in advance of sample collection, shall not begin until a developed well has been allowed to stabilize for at least 72 hours, but shall take place as soon thereafter as is feasible and (if possible) in coordination with any surface water sampling that may be required in that area. Due to the sampling methods and field parameter measurements required, the development purge may not be substituted for any of the pre-sampling purge.

Because the wells installed through this WP are intended to support different types of decisions, analytical requirements vary. In addition, due to the potential for surface water contamination in the vicinity of some wells, collection of surface water grab samples concurrent with groundwater sampling may be required. Surface water grab samples for VOC analysis shall be collected via container immersion methods, in accordance with RMRS/OPS-PRO.081; if proper use of this method is not feasible, for example because the water depth is too shallow, collection via water transfer, using either a peristaltic pump equipped with new tubing or a decontaminated stainless steel dipper or similar transfer device may be performed. The specific methods used to collect surface water grab samples shall be documented in detail in the field logbook (or field sample collection forms, as appropriate).

5.1 General Requirements

All wells sampled as part of this WP shall be purged and sampled using low-flow (micropurge) techniques in accordance with SOP RMRS/OPS-PRO.113, Groundwater Sampling, and RMRS/OPS-PRO.108, Measurement of Groundwater Field Parameters, with the modifications specified in this WP. Sampling of the wells shall be performed by pumping or bailing as described in these SOPs, but shall include measurement of redox field parameters (items 5 through 11 in Table 2, presented in Section 5.1.2).

Collection of the VOC sample is usually the primary goal of any sampling event that includes measuring redox parameters. Except at the Ash Pits and 400 Area, all of the newly installed wells in this WP will require VOC collection as the highest priority sample. (At the Ash Pits and 400 Area, VOCs shall not be collected. At the Ash Pits, redox parameters need not be measured. However, if a redox parameter such as oxidation-reduction potential [ORP] or dissolved oxygen [DO] is automatically measured by the instrument being used, the results shall be recorded along with the other, non-redox parameters.) Sampling at the Ash Pits will not require the use of a low-flow purge and sampling technique discussed in this section. Where analytes other than VOCs or total petroleum hydrocarbons (TPH) are being collected, those other analytes need not be collected using low-flow methods. If the crew desires, the remainder of the analytical suite (i.e., other than VOCs and TPH) may be collected using a higher pumping rate (not to exceed 300 ml/min.) or traditional bailer methods. This is left to the crew's discretion, unless the WARP Project Manager provides specific instruction. All sampling shall be performed with due care and attention to quality and, except as specifically modified by this WP, in accordance with SOP RMRS/OPS-PRO.113.

5.1.1 Purging and Sample Collection

Ash Pits
The five monitoring wells at the Ash Pits (two new wells, three pre-existing wells) shall be purged and sampled with a peristaltic pump if possible, using low-flow sampling methods described in greater detail in RMRS/OPS-PRO.113 and the text below. If using a peristaltic pump is not possible (i.e., because the water level is too deep), samples may be collected using a bailer. Measurement of redox parameters identified in Section 5.1.2 need not be made. The detailed instructions presented below regarding purge completion criteria, low-flow sampling, and other more general sampling issues also apply to Ash Pits wells; only those instructions that pertain strictly to redox field parameters and VOC issues may be disregarded for Ash Pits wells. However, as noted above, if the instrument being used to measure field parameters automatically measures such parameters as ORP or DO, the results shall be recorded along with the other, non-redox parameters.

The analytical data will be most useful if all wells are sampled in the same period of time, rather than separated by several weeks or months. If this is not feasible, the groundwater sampling crew shall inform the WARP Project Manager of the conditions at the five wells prior to initiating sampling at any location in case postponement of all sampling at the Ash Pits is the preferred alternative. Collection of surface water grab samples concurrently with groundwater sampling is also desirable, but dry conditions in Woman Creek will not postpone groundwater sampling.

All Other Areas
A peristaltic pump shall be used to purge most wells and collect most samples, but exceptions will apply in some instances. For example, if the water level is too deep for a peristaltic pump, the well shall be purged and sampled very carefully (so as not to agitate the water and cause VOC loss or a change in redox conditions) using a bailer.

Where peristaltic pumps are used, drawdown in the well shall be carefully monitored using a water level sounder, and shall be minimized (it should be less than 1') to ensure that micropurging techniques are being used and to allow early recognition of dewatering conditions. The water level sounder shall be lowered gently into the water column to minimize aeration of the water.

Where a peristaltic pump is used, the intake of the pump shall be set 1' above the bottom of the screen, to maintain consistency among all wells. Utilizing micropurge techniques, groundwater shall be pumped at a maximum rate of 100 ml/min. throughout the purge and extending through collection of the VOC sample and the aliquot necessary for the measurement of redox parameters.

Criteria to be used to determine when the purge is complete using a peristaltic pump shall be removal of at least one initial casing volume and stabilization of parameters 1 through 4 in Table 2.

Collection of any additional analytical samples need not be performed using micropurging methods. The remaining suite may be pumped at a rate up to 300 ml/min. using a peristaltic pump, or collected using a bailer. Samples for the analysis of metals and uranium isotopes shall be collected using an in-line, 0.45-micron filter.

Sample collection shall proceed in accordance with methods set forth in RMRS/OPS-PRO.113, Groundwater Sampling, as modified herein. Vials for VOC analysis shall be filled to zero headspace and chilled immediately after collection to 4 degrees Celsius (4ºC). All samples shall be handled, preserved, transported, and shipped in accordance with RMRS/OPS-PRO.069, Containing, Preserving, Handling, and Shipping Soil and Water Samples, and PRO-908-ASD-004, Onsite Transfer and Offsite Shipment of Samples.

5.1.2 Field Parameters

Most field parameters shall be measured using a flow-through cell attached to a YSI multiparameter probe. For some parameters (numbers 7 through 12 in Table 2 below), this will not be feasible; for these parameters, a Hach DR2010 (or newer) spectrophotometer and appropriate parameter-specific test kit shall be used to measure them. DO will be measured using both instruments and methods, as specified in Table 2.

Table 2. Field parameters to be measured and the method to be used.

Parameter	Method
1. Water temperature	YSI
2. pH	YSI pH probe
3. Specific conductance	YSI conductivity probe
4. Turbidity	YSI turbidity probe
5. Oxidation/Reduction Potential (ORP)	YSI using Pt working electrode vs. Ag/AgCl
6. Dissolved oxygen (DO) (mg/L)	YSI oxygen probe
7. DO (mg/L)	DR2010 spectrophotometer HRDO method
8. Ferrous iron	DR2010 spectrophotometer phenanthroline method
9. Iron (II+III)	DR2010 spectrophotometer FerroVer method
10. Sulfide	DR2010 spectrophotometer methylene blue method
11. Sulfate	DR2010 spectrophotometer SulfaVer method
12. Total alkalinity	Orion Total Alkalinity reagent

Several redox field parameters (numbers 5 through 11 in Table 2) shall be measured. Field parameters shall be measured in accordance with SOP RMRS/OPS-PRO.108, Measurement of Groundwater Field Parameters, and/or the appropriate instrument or test kit manufacturer's instructions.

If dilution is required to bring the sample water into range for the instrument and/or method, care shall be taken in decontaminating dilution equipment, measuring aliquots, and minimizing oxygenation of the sample and diluting waters, especially if the dilution is for the measurement of sulfide or ferrous iron. Dilution equipment shall be decontaminated immediately prior to use and shall be rinsed with sample water after decontamination to acclimate it to the sample water. The results of pre-dilution measurements shall be recorded, as shall successive dilutions and the calculations and volumes used to form the diluted sample. These data shall be included on the sampling form (SOP RMRS/OPS-PRO.113).

Appearance, odor, time, volume purged, and water level (drawdown) shall also be monitored and recorded as the purging and sampling proceeds. The presence or absence of the "rotten-eggs" odor of hydrogen sulfide is of particular interest.

The first four parameters listed in Table 2 (temperature, pH, specific conductance, and turbidity) shall be used to determine and confirm stabilization has been achieved. While not used for stabilization purposes, the fifth and sixth parameters (ORP and DO using the YSI probe) shall be recorded at the same frequency as the first four parameters listed in Table 2.

The last six parameters listed in Table 2 (DO using the DR2010, both iron measurements, both sulfur measurements, and alkalinity) shall be measured at the end of the purge. Of these parameters, DO, ferrous iron, and sulfide (numbers 7, 8, and 10) shall be measured first to obtain the best results for these redox parameters. No samples shall be collected, nor shall the last six parameters be measured, until all of the first four parameters have stabilized to the limits defined in

RMRS/OPS-PRO.108 and RMRS/OPS-PRO.113. Exceptions to these field parameter requirements exist for wells that may dewater, as discussed in the next section.

5.1.3 Dewatering Wells

If micropurging techniques are performed correctly and the well is receiving ample recharge, no well will dewater. However, if the minimum pump rate causes drawdown to the point that well dewatering is deemed very probable or certain, additional considerations and instructions apply.

- To ensure the potential for dewatering is known in advance of it actually occurring, the water level in the well shall be monitored throughout the purge. (This is also done to confirm that micropurging techniques are being used in wells that will support their use.)

- If dewatering appears probable (based on a comparison of the pump rate, an educated guess of how much additional volume might be needed to reach parameter stabilization, the volume needed for samples, and the calculated volume of water still present in the well), the crew shall notify the WARP Project Manager in case alternate instructions are warranted.

- As dewatering becomes imminent, unless instructed otherwise by the WARP Project Manager the crew shall perform the appropriate actions to address the following priorities (listed in the order of importance):
  1. VOC sample collection and other prioritized samples;
  2. Collection/measurement of redox field parameters (parameters 7 through 11 in Table 2);
  3. Collection of other analytical samples
  4. Stabilization of field parameters (parameters 1 through 4 in Table 2).

As indicated, except at the Ash Pits and 400 Area (which are discussed separately at the end of this subsection), the highest priority is to collect the VOC samples. Therefore, if dewatering appears imminent, purging shall cease while there is still sufficient water for the VOC sample. Any water remaining after sample collection may be used for the field parameters. It would be acceptable to slowly lower the peristaltic pump intake to the bottom of the screen in order to maximize the water volume recovered from the well.

If the well dewaters despite the crew's best efforts, they shall immediately notify the WARP Project Manager. The crew shall then perform a ten-minute recharge calculation in accordance with RMRS/OPS-PRO.113. The crew shall immediately relay the results to the WARP Project Manager as appropriate for guidance. The crew may be directed to continue purging, to collect final field parameters and samples, or to return within the following 24 hours to collect field parameters and samples.

Because VOCs will not be part of the analytical suite at the Ash Pits and 400 Area, a properly low-flow-purged well may be allowed to dewater and a return visit may be scheduled for sample collection.

5.1.4 Dry and Technically-Dry Wells

Wells that are completely or "technically" dry shall be visited only once. Determination of technically-dry status (i.e., the well contains no water above the bottom of the screen) shall be made carefully to ensure wells that might produce samples are not inadvertently eliminated from sampling activities, or those activities are not erroneously postponed.

5.2 Surface Water Grab Sampling

Surface water grab sampling shall be performed in selected areas, as identified in Section 5.3 and on Figure 2. Surface water grab samples shall be collected from the deepest portion of the

accessible water column at the specific target location, and by the container immersion technique. To the extent feasible, VOC samples shall be collected from water nearest the bottom of the water column. Other analytical samples may be collected from shallower portions, but none should be skimmed from the surface if this can be avoided.

One set of surface water field parameters shall be measured at each surface water grab sampling location, and shall include temperature, pH, specific conductance, turbidity, ORP, DO, and total alkalinity. A YSI multiparameter probe may be used for all save total alkalinity, which should be measured using the method identified in Table 2. Field parameters shall be measured directly in the stream or pond, if possible. Other redox parameters (items 7 through 11 in Table 2) shall not be measured in surface water. Surface water grab samples shall not be filtered.

Stream samples shall be collected from a relatively deep portion of the actively-flowing reach. (This may not be possible for locations within the SID, as that channel very rarely flows.) The collection point shall be biased toward the potential contaminant source area; for example, if the location is being sampled to evaluate whether a groundwater plume is impacting the surface water, the sampling should be conducted from the side of the stream channel closest to the plume. Sampling locations selected solely to support the CRA project have been defined by the CRA lead, and reflect groundwater plume locations, consistency with other locations in the same drainage, or other considerations (such as access issues).

At stream/SID locations, it may be necessary to perform minor drainage modification to provide a point in the drainage that is sufficiently deep to use the container immersion procedure. If the streambed is modified for this purpose or for any other reason prior to sampling, a minimum of ten minutes shall be allowed to pass before water samples are collected at that location.

As with stream samples, pond samples shall be collected from the edge of the pond closest to the source of potential contamination. For example, because Pond C-1 is to be sampled for data on whether the Ryan's Pit/903 Pad Plume is impacting the surface water in this pond, samples shall be collected from the northern edge of the pond because the plume approaches this pond from the north.

If it appears that the container immersion method will not be successful even with drainage modification, but the surface water body does contain sufficient water for sampling, a transfer device or peristaltic pump may be used to collect the necessary samples if approved in advance by the WARP Project Manager. If the latter method is approved, the surface water sampling crew shall take care to minimize the amount of sediment pumped. This is particularly important for samples to be analyzed for inorganic constituents.

Several of the surface water sampling locations identified in this WP coincide with a historic sampling location (i.e., one that has been sampled in the past as part of a Rocky Flats surface water monitoring program). These locations are often marked in the field with small signs mounted to metal fence posts. Where this WP instructs that a sample shall be collected at a historic sampling location, there should be no deviation from that sampling location. If the historic sampling location is not appropriate for some reason and the actual samples must be collected from a different location (i.e., more than ten feet away from the historic location), the actual sampling location shall be assigned an identification code other than that of the historic sampling location by adding the suffix "03" or "04" (depending on whether samples are collected in CY03 or CY04) to the historic location code. This will help to minimize inappropriate comparison of older data with those collected via this WP. Figure 2 identifies sampling locations using the suffix that is expected to be accurate; however, these may be changed if necessary.

Any necessary adjustment of sampling locations to allow successful surface water sampling shall honor the intended surface water target. For example, if a potentially-impacted historic location is to be sampled but an unimpacted tributary enters the stream a short distance downstream of the

posted location and offers better sampling conditions, sample collection shall not be moved to the downstream location because the tributary is not the intended target.

If any of the stream locations to be sampled in an area (for example, in the Ash Pits area, the B-Ponds area, etc.) are not actively flowing, and/or if any designated pond sampling locations in an area do not present sufficient water for sampling, the surface water sampling crew shall identify which locations will not provide samples for that particular area. The crew shall then notify the WARP Project Manager prior to beginning surface water sampling activities to determine whether a postponement of all surface water sampling is desired. (This does not apply to locations in the SID, as it is not expected to be flowing.) Also, if the water level of a pond is relatively low, the flag marking the collection point shall be positioned so as to remain above the level of the pond under more normal conditions.

All locations within a single drainage should be sampled in as short a time frame as is feasible, because the CRA project and other data users will compare data collected from all locations within a given drainage. For example, it would not be desirable to collect samples from one portion of a drainage and postpone sampling other portions for weeks or months.

Descriptions of actual sampling locations, conditions (flow, pond level, water appearance, etc.), any necessary streambed modifications, and other information and observations that may be pertinent to sampling procedures and/or the resulting water quality data shall be recorded in detail in a field logbook identified for use with this WP and completed in accordance with PRO-1457-UL, Use of Logbooks. Actual sampling locations shall be surveyed using engineering or GPS methods following sample collection.

Surface water locations to be sampled as part of this WP are shown on Figure 2. Other locations shall be identified in the field following the general guidelines presented below in Section 5.3.

5.3 Area-Specific Requirements

The following area-specific requirements apply.

5.3.1 Ash Pits

At the Ash Pits, both new wells and three pre-existing wells shall be sampled. This will provide groundwater data downgradient of each of the five Ash Pits from which elevated levels of soil contamination (beryllium and/or uranium-238) have been reported.

Surface water grab samples shall be collected from upstream of the Ash Pits at the sampling point for gaging station GS05, and immediately downstream of the Ash Pits but upgradient of the nearby confluence in the vicinity of historic sampling location SW506. During a field walkdown of this area, the marker for location SW506 could not be found. A new sampling location was identified and marked SW50604, and shall be used for collection of this sample.

Comparison of the results from these two surface water sampling locations may indicate whether the Ash Pits area is contributing contaminants to Woman Creek. If contamination is indicated, additional follow-up surface water sampling may be performed at the discretion of the WARP Project Manager at locations between these two stations, possibly including SW039, SW040, and/or newly established locations (for example, due south of well 63093). Exact locations of follow-up sampling shall be determined in the field through consultation with the WARP Project Manager, who will consult the CRA project lead if appropriate. If any follow-up surface water sampling is performed, resampling at locations GS05 and SW50604 shall also be performed to ensure all resulting data are comparable.

5.3.2 OBP/Mound/B991

Because of the extensive reconfigurations of the South Walnut Creek drainage in this area and the presence of multiple culverts from various areas of the IA (some of which are known to leak), opportunities for surface water grab sampling is limited here. One location north (downgradient) of the Mound Plume will be sampled. This location has been selected to be downgradient of well 15699, which shows the highest VOC concentrations measured downgradient of the associated groundwater intercept and treatment system. This location will be identified SWMP04.

5.3.3 Ryan's Pit/903 Pad Plume

Surface water grab samples shall be collected from the SID, Woman Creek, and the C-Ponds (Figure 2). Grab samples shall be collected both upstream and downstream of the well installation area.

Five surface water grab samples shall be collected from the SID/Woman Creek/Pond C-1 in this area, and one shall be collected from Pond C-2. One sample shall be collected from Woman Creek just west of the C-1 inlet in the vicinity of historic station GS17, one shall be collected from the northern bank of Pond C-1, one shall be collected from below the C-1 outlet, and one shall be collected a short distance farther east. None of these locations shall be sampled unless and until all four present sufficient water for sampling. If water is present in the SID in the area of the downgradient front of the Ryan's Pit/903 Pad Plume, it too shall be sampled.

The sample collected from the GS17 area will provide upgradient water quality information. This may be important due to the numerous IHSSs on the 881 Hillside, to confirm whether contamination that may be indicated in the downstream samples is due to the influence of the Ryan's Pit/903 Pad Plume. The sampling location shall be identified and flagged GS1704.

The Pond C-1 sample will potentially provide the least aerated sample, and therefore may be most likely to retain VOC contaminants that may be present. However, it is also likely to be the most diluted, so the use of proper sample collection techniques will be important. This sample shall be collected from the deepest portion of the accessible water column at the northern pond edge, adjacent to the dam. An appropriate location would be the inlet of the culvert that drains Pond C-1, outside the concrete box and grate assembly. The location shall be identified and flagged as SWC104.

The location immediately downstream of Pond C-1 shall be positioned as close to due north of well 51193 as is feasible. Because this well has produced groundwater samples with detections of VOCs, it has been mapped as within the distal portion of the Ryan's Pit/903 Pad Plume. Collecting a surface water grab sample from Woman Creek at this location may provide useful data to determine the potential for contaminants to discharge to Woman Creek. Well point 54593, located on the northern side of Woman Creek and marked with a sign on a metal post, may provide a more convenient landmark due to the heavy vegetation in this area; this well is slightly (10-15') north northwest of the desired sampling location. Because of the heavy vegetation and deeply-incised, rocky nature of the creek channel here, the actual sampling location will need to be selected by the field sampling team. It should be no farther east of the Pond C-1 outlet than 150', and shall be identified and flagged as SW51104.

The location farther downstream of Pond C-1 shall be identified as SWWC204. Data from this location will document any changes in water quality compared with samples collected from SW51104, which is essentially within the potentially impacted portion of Woman Creek. Pond C-2 shall be sampled for similar comparison purposes. This location will be identified SWC204.

If surface water, flowing or stagnant, is present within that portion of the SID that is within or in the downgradient vicinity of the Ryan's Pit/903 Pad Plume, it will be sampled. Field walkdowns

performed in the spring of 2004 confirmed the presence of water in the SID near surface water station GS52. The grab sampling location will be identified GS5204.

5.3.4 PACS 2 Parking Lot

One surface water grab sample shall be collected from the outfall of the culvert in this buried drainage (east of B371/374). Collection via container immersion may not be feasible here. Ideally, the sample shall be collected from the water discharging from the culvert, before it actually discharges (i.e., still within the culvert). If this is not feasible, the sample shall be collected from as close to the culvert lip as is possible to minimize the effects of aeration. If these locations will not support sample collection, the sampling crew shall notify the WARP Project Manager for direction. This sampling location shall be identified as SW33503. Additional analytes to support the CRA project are not required at this location.

5.3.5 400 Area

In addition to new well 44303, existing wells 44202, 40199, P218289, 85202, and P414189 shall be sampled. Well P414189 is currently equipped with a down-hole water level transducer and data logger, which shall be removed with extreme care, placed in a new plastic bag, and reinstalled to its original depth immediately upon completion of sampling activities. Should any of these activities require multiple visits to complete, this downhole equipment shall be reinstalled as soon as activities are completed each visit. The field crew shall be extremely careful to reinstall the equipment to same depth as it was originally installed.

Surface water grab samples shall be collected from the SID and Woman Creek to support the CRA project (Figure 2). Analytical data from these samples will be used to evaluate whether surface water in this area may be impacted by the South Industrial Area Plume (SIAP) or the Original Landfill. A historic sampling location on the SID, SW038, will be sampled to provide water quality information upstream of the Original Landfill and SIAP. A second location on the SID, selected to be downstream of the Original Landfill and possibly within the SIAP, is near historic station SW036; the grab sampling location shall be identified SW03604. Data from this location will be used to evaluate potential impacts from those two sources on surface water quality in the SID. Directly below (downhill, to the south) SW03604, Woman Creek shall be sampled to evaluate whether any water quality impacts observed in the SID also extend to Woman Creek. This location shall be identified SWWC104.

5.3.6 East Trenches Plume

Surface water samples collected previously by the CDPHE from upper B-Ponds, as well as groundwater data from well 23296 located below Pond B-2, indicate the East Trenches Plume has impacted surface water in this area. The contamination that is present in the B-Ponds and well 23296 is thought to represent residual contamination from that portion of the plume that is downgradient of the East Trenches Plume Treatment System (ETPTS) – an area of contamination that predates the ETPTS and was therefore not intercepted or treated by this system. However, the fate and extent of this contamination – which ponds are contaminated and whether the contamination is present in stream reaches downstream of contaminated ponds – has not been confirmed.

Eight surface water grab samples shall be collected from the South Walnut Creek drainage in the vicinity and downstream of the East Trenches Plume. (A ninth shall also be collected farther upstream in the vicinity of the Mound Plume; this location is discussed above in Section 5.3.2.) The specific locations are listed and assigned identification codes below:

1. Surface water monitoring station SW023, upstream of Pond B-1, retaining identification SW023;
2. The southern bank of Pond B-1, identified as SWB104;

3. The southern bank of Pond B-2, identified as SWB204;
4. The southern bank of Pond B-3, identified as SWB304;
5. The flow between Pond B-3 and Pond B-4, identified as SWB3B4;
6. The southern bank of Pond B-4, identified as SWB404; and
7. Surface water monitoring station SW024, downstream of Pond B-4, retaining identification SW024.
8. The southern bank of Pond B-5, identified as SWB504.

The data collected through this WP will provide additional information on impacts to the upper B Ponds and the intervening reaches of South Walnut Creek by the East Trenches Plume. These data will also help to determine whether VOCs measured in pond waters volatilize as the water flows from one pond to another. Because there is no such flow from Pond B-1 to Pond B-2, or from Pond B-2 to Pond B-3, only the flow between Ponds B-3 and B-4, and between Ponds B-4 and B-5, will be sampled for this purpose.

The SW023 sample will provide data on water quality upstream of the B-Ponds, and those from Pond B-4, Pond B-5, and the intervening drainage will provide data on water quality downstream of the potential extent of surface water impacts from this plume.

Each of the pond samples shall be collected in a manner similar to that specified for Pond C-1; that is, from the deepest portion of the accessible water column. In the case of the B-Ponds, water from the southern edge of each pond shall be sampled. Locations shall be marked and labeled in the field using the nomenclature identified above. Except for locations SW023 and SW024, actual sample locations may be adjusted from those shown on Figure 2 in order to coincide with deeper water, as long as they satisfy the DQOs of this sampling. If SW023 will not support sampling but another location in the immediate vicinity will, this location shall be marked and identified as SW02304.

Each of the stream samples shall be collected from a relatively deep portion of the actively-flowing reach near the southern edge of the stream. This may require minor drainage modification to provide a point in the drainage that is sufficiently deep to use the container immersion procedure. If the streambed is modified for this purpose or for any other reason prior to sampling, a minimum of ten minutes shall be allowed to pass before water samples are collected at that location.

If all stream locations are not actively flowing, the sampling crew shall identify which locations will not provide samples, then notify the WARP Project Manager prior to beginning sample collection activities to determine whether a postponement of all surface water sampling is desired. Also, if the water level of a pond is relatively low, the flag marking the collection point shall be positioned so as to remain above the level of the pond in a normal water year.

5.4 Analytical Requirements

Table 3 identifies the well-specific analytical samples to be collected, as well as any additional sampling (groundwater) required. (Well 00203 is omitted from Table 3 because, as a replacement for IMP well 00297, its analytical suite will be identical to that currently assigned to well 00297.) Following completion of all well installation and sampling activities described in this WP, the resulting data will be evaluated as summarized in Section 3. As appropriate, based on evidence of groundwater contamination, proximity to surface water, surface water quality, and any other factors that may be relevant (for example, core descriptions), wells will be considered for regular monitoring and addition to the IMP. Data from wells in the PACS 2 area will also be assessed to determine whether a fourth well should be installed and sampled to further delineate the plume extent.

Table 4 identifies specific surface water sampling locations and the analytic suites to be completed for each. The locations have been flagged and will be surveyed after sampling. If a sampling location is dry it will be noted and no sample will be collected.

Samples for Department of Transportation (DOT) radiological screening purposes are not included in Tables 3 and 4. They shall be collected only if so directed by the Radiological Engineer. Bottle sizes, sample preservation, and the specific laboratory analytical methods to be used shall be the same as for routine groundwater samples.

Samples shall be shipped using the same handling, shipping, and turnaround-time requirements as are used for routine samples.

5.5 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) samples shall be collected to support this investigation. The standard ratio of real to QA/QC samples, as applied to the Groundwater Monitoring Program, shall also apply here, both to groundwater and surface water sampling activities. This ratio is one duplicate and one equipment rinse sample per twenty real samples.

Duplicate samples shall be collected from the same water as real samples, alternating to fill a real sample container, then a duplicate sample container, then a real sample container, and so on. Equipment rinse samples shall be collected in the field from the same equipment used to collect the samples, immediately after that equipment has been decontaminated. This equipment shall be used to transfer distilled or deionized water (e.g., via pumping or bailing, as appropriate) to sample containers. Collection of the equipment rinse samples shall be performed in the field, at the location from which the real samples were collected.

All activities shall be performed in accordance with the applicable SOPs and other pertinent Site procedures and requirements. Timely, accurate, and complete documentation of activities, measurements, results, observations, and other relevant aspects shall be recorded in field logbooks and/or field forms included in the SOPs, as appropriate.

Quality assessments (field audits) of field activities may be performed at any time, with or without advance notice, by the WARP Project Manager or designee. Field visits or quality assessments may also be performed by other individuals associated with this project through their supervisory responsibilities, data needs, contractual associations, or Site QA/QC responsibilities.

Any deviations from this WP or SOPs that pertain to this project shall be documented in detail and discussed with the WARP Project Manager as soon as possible in case well replacement, well design changes, resampling a well, or other actions are necessary.

Table 3. Groundwater sample collection and analysis.

Sample Location	General Area	VOCs	U-isotopes	Metals	TPH
13103	Ash Pits		X	X	
13403	Ash Pits		X	X	
59093	Ash Pits		X	X	
63093	Ash Pits		X	X	
58793	Ash Pits		X	X	
91103	OBP	X	X	X	X
91203	OBP	X	X	X	X
99603	B991	X	X		
90603	Ryan's Pit/903 Pad Plume	X	X		
90703	Ryan's Pit/903 Pad Plume	X	X		
90803	Ryan's Pit/903 Pad Plume	X	X		
90903	Ryan's Pit/903 Pad Plume	X	X		
33603	PACS 2	X			X
33703	PACS 2	X			X
33803	PACS 2	X			X
44303	400 Area	X			X
44202	400 Area				X
40199	400 Area				X
85202	400 Area				X
P218289	400 Area				X
P414189	400 Area				X
95503	East Trenches Plume	X			

Table 4. Surface water sample collection and analysis. See Figure 2 for location map. Shading indicates samples that will support Water Programs DQOs (see footnote for important distinction regarding radionuclide analytes); all others will support the Comprehensive Risk Assessment project.

Sample Location	General Area	VOCs	SVOCs	Radio-nuclides[1]	Metals	Nitrates
GS05	Woman Creek upstream of the Ash Pits	X	X	X	X	
SW50604	Woman Creek downstream of the Ash Pits	X	X	X	X	
SW038	SID upstream of the Original Landfill	X	X	X	X	
SW03604	SID downstream of the Original Landfill	X	X	X	X	
SWWC104	Woman Creek downstream of the Original Landfill	X	X	X	X	
GS1704	Woman Creek upstream of Ryan's Pit/903 Pad Plume	X	X	X	X	
SWC104	North edge of Pond C-1	X	X	X	X	
SW51104	Woman Creek just downstream of Pond C-1	X	X	X	X	
GS5204	SID downgradient of Ryan's Pit/903 Pad Plume	X	X	X	X	
SWWC204	Woman Creek farther downstream of Pond C-1	X	X	X	X	
SWC204	Southern edge of Pond C-2 near inlet	X	X	X	X	
SWMP04	South Walnut Creek downgradient of Mound Plume	X	X	X	X	
SW023	South Walnut Creek upstream of the East Trenches Plume	X	X	X	X	
SWB104	Southern edge of Pond B-1	X	X	X	X	
SWB204	Southern edge of Pond B-2	X	X	X	X	
SWB304	Southern edge of Pond B-3	X	X	X	X	
SWB3B4	Spillway where Pond B-3 water flows toward Pond B-4	X	X	X	X	
SWB404	Southern edge of Pond B-4	X	X	X	X	
SW024	South Walnut Creek downstream of Pond B-4	X	X	X	X	
SWB504	Southern edge of Pond B-5	X	X	X	X	
SW11804	North Walnut Creek near former PACS 3 (B771 area)	X	X	X	X	X
SWNWC04	North Walnut Creek downgradient of the Solar Ponds Plume	X	X	X	X	X
SWA104	Southern edge of Pond A-1	X	X	X	X	X
SWA204	Southern edge of Pond A-2	X	X	X	X	X
SWA304	Southern edge of Pond A-3	X	X	X	X	X
SWA404	Southern edge of Pond A-4	X	X	X	X	X
SWLF04	Southern edge of Present Landfill Pond near Landfill face	X	X	X	X	
SW33503[2]	Southeast of B371/374	X				

1. Radionuclides will include americium, plutonium, uranium-234, uranium-235, and uranium238. ONLY THE URANIUM ISOTOPES are requested by Water Programs; Pu and Am are requested by the CRA project.
2. Location 33503 was sampled prior to addition of CRA scope to this WP and will not be resampled.

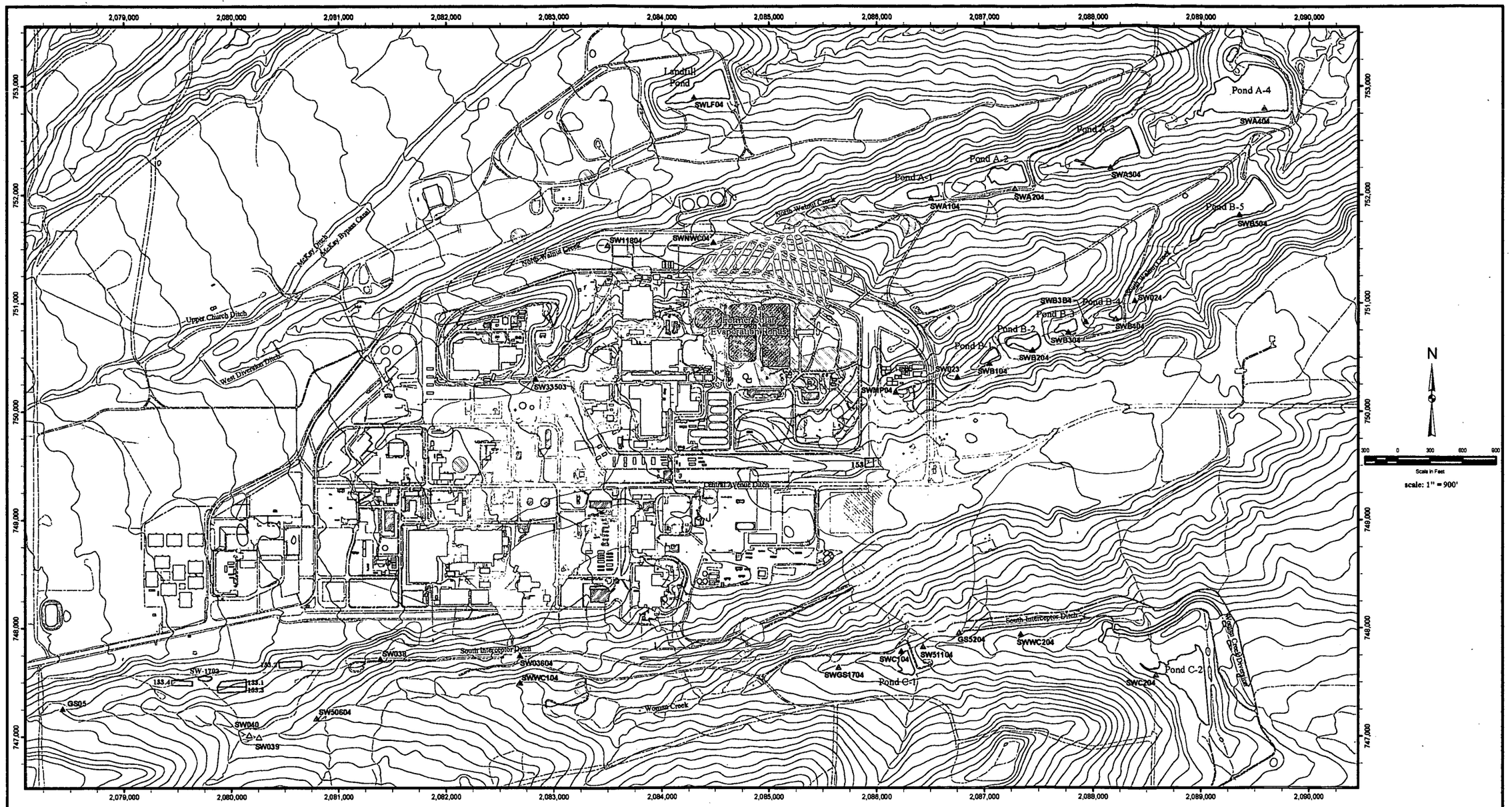
Legend

- Approximate location of proposed well installation
- Pre-existing well
- 133.4 Individual Hazardous Substance Site location and number
- SW-1702 Potential Area of Concern location and number
- Building or other structure
- Demolished building
- Pond
- Stream, ditch, or other drainage feature
- Paved Road
- Dirt Road
- 10 ft Topographic Contour
- Groundwater Intercept System
- >Tier II, selected VOCs
- >Tier II, nitrate

(Selected VOCs and nitrate from 2002 Annual RFCA Groundwater Monitoring Report)

Figure 1
Calendar Year 2003 Well Installation and Sampling Project: Well Installation

June 17, 2004



Legend

- ▲ Approximate location of proposed surface water sampling location
- ▲ Selected pre-existing surface water sampling location
- △ Selected pre-existing surface water location
- 133.4 Individual Hazardous Substance Site location and number
- SW-1702 Potential Area of Concern location and number
- Building or other structure
- Demolished building
- Pond
- Stream, ditch, or other drainage feature
- Paved Road
- Dirt Road
- 2 ft Topographic Contour
- Groundwater Intercept System
- >Tier II, selected VOCs
- >Tier II, nitrate

(Selected VOCs and nitrate from 2002 Annual RFCA Groundwater Monitoring Report)

Figure 2
Calendar Year 2003
Well Installation and
Sampling Project:
Surface Water Sampling Locations

June 17, 2004